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(H11-186945)

[Claims]

[Claim 1] A portable radio information terminal comprising a main body for containing an information processing unit and a cover for containing said main body and covering a top surface of said main body by being closed,

said portable radio information terminal being characterized in that when said cover is closed, a back side of said cover is brought closer to the top surface of said main body, and when said cover is open, said back side is brought away from said top surface of said main body, said cover includes a first antenna disposed at an end part of said cover and a second antenna including a contactor plane having an effect for shielding electric connection between said cover and said main body, and said cover further includes a reception unit for receiving a reception radio signal from said second antenna when said cover is closed and for conducting diversity reception of the reception radio signal through said first and second antennas when said cover is open.

[Claim 2] A portable radio information terminal according to claim 1 characterized in that when said cover is open, a transmission unit transmits a generated transmission radio signal through said first antenna, and

when said cover is closed, said transmission unit transmits the transmission radio signal through said second antenna.

[Claim 3] A portable radio information terminal according to claim 2 characterized in that said cover further comprises a third antenna including a

conductor plane having an effect for shielding an electromagnetic connection between said cover and said main body,

said reception unit conducts diversity reception using said first and second antennas when said cover is open, and said reception unit conducts diversity reception using said second and third antennas when said cover is closed.

[Claim 4] A portable radio information terminal according to claim 1 characterized in that said first antenna is a whip antenna and said second antenna is an inverted-T antenna.

[Claim 5] A portable radio information terminal according to claim 1 characterized in that said conductor plane of said second antenna is a printed board on which parts of said radio unit are mounted.

[Claim 6] A portable radio information terminal according to claim 1 characterized in that said conductor plane of said second antenna is a metal vapor deposited on a housing of said cover.

[Claim 7] A portable radio information terminal according to claim 3 characterized in that said first antenna is a whip antenna and said second and third antennas are inverted-F antennas, respectively.

[Claim 8] A portable radio information terminal comprising a main body for containing an information processing unit and a cover mechanically connected to said main body through a rotation shaft, containing said radio unit and covering a top surface of said main body by being turned about said rotation shaft,

said portable radio information terminal being characterized in that said cover includes a first antenna whose distal end part is disposed at an end

part on the side opposite to said rotation shaft and a second antenna including a ground conductor disposed at a back side, and

said cover further includes a reception unit for receiving a reception radio signal through said second antenna when said the top surface of said main body is covered by said cover and for conducting diversity reception of the reception radio signal through said first and second antennas when the top surface of said main body is not closed by said cover.

[Claim 9] A portable radio information terminal according to claim 8 characterized in that said first antenna is a whip antenna and said second antenna is an inverted-F antenna.

[Claim 10] A portable radio information terminal according to claim 9 characterized in that when the top surface of said main body is not closed by said cover, a transmission unit transmits a generated transmission radio signal through said first antenna, and

when the top surface of said main body is closed by said cover, said transmission unit transmits the transmission radio signal through said second antenna.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Pertains] The present invention relates to a portable radio information terminal having a radio communication function (radio unit) and an information processing unit (information processing unit), and more particularly, to an antenna structure of a portable radio information terminal.

[0002]

[Related Art] In conventional radio portable information terminal of this type, there is encountered with such a serious problem that noises generated from the information processing unit exert significant adverse effects to the radio unit, particularly to a receiving system through an antenna and as a result, radio characteristics, particularly S/N of the reception radio signal is deteriorated (receiving sensitivity is deteriorated).

[0003] One way for solving this problem is to divide the radio portable information terminal into a main body and a cover. For example, the main body receives therein the information processing unit and is provided at the top surface with a display, while the cover covering the surface of the main body receives therein the radio unit and the antenna. Moreover, an antenna selecting diversity reception system may be employed as generally used in a portable telephone, in which a plurality of antennas are disposed at the radio unit and an antenna having a large reception electric field strength is selected so that reception radio signal is received through this antenna.

[0004] FIG. 7 is a block diagram showing one example of a radio portable information terminal using the above techniques.

[0005] In this radio portable information terminal, the information processing unit is received in the main body 1A and the radio unit is received in the cover 2B. The cover 2B is mechanically connected at one end part thereof the an end part of the main body 1A through a shaft (20) such as a hinge shaft or the like. The cover 2B is opened/closed relative to the top surface of the main body 1A serving the shaft (20) as a rotation shaft.

[0006] The main body 1A contains a battery 3 serving as a power source of this information terminal and a control unit 4B for conducting information

processing of data or digital signal to be input/output with respect to the cover 2B. This information terminal outputs image data through a display unit 5 which is disposed at the top surface of the main body 1A. Such operation as information processing is performed by inputting signal generated by superposing a pressure sensitive device (for example, touch panel) on the display unit 5, i.e., by inputting control signal coming from the input unit 6 into the control unit 4B. The control unit 4B excluding the battery 3, the display unit 5 and the input unit 6 normally constitute information processing unit.

[0007] On the other hand, the cover 2B includes two antennas, a whip antenna 7 projecting from the cover 2B and forming a rod-like configuration and an inverted-F antenna 9A disposed at the bottom side (back side) on the main body side of the cover 2B. The radio unit had by the cover 2B includes a transmission unit 13 for generating transmission radio signal, an antenna switch 16 for selecting the reception radio signal to signal coming from either the antenna 7 or 9A, a reception unit 11 converting and amplifying the selected reception radio signal and receiving the same as reception signal, a circulator 10 for sending the transmission radio signal to the switch 16 and sending the reception radio signal coming from the switch 16 to the reception unit 11, and a modulation/demodulation unit 12 for modulating data or digital signal coming from the control unit 4B and sending the same to the transmission unit 13 and demodulating reception signal coming from the reception unit 11 and sending digital signal as the demodulated data to the control unit 4B. The modulation/demodulation unit 12B includes a radio control unit for controlling the radio unit. The radio control unit conducts

frequency selection control of the transmission/reception signal, level control of the radio signal outputted from the transmission unit 13, and switch control of the antenna switch 16 and so forth. The circulator 10 has the role for acting as an isolator in which the input/output signal of the antenna 7 or 9A is hardly affected by the reception unit 11 or transmission unit 13 which is not required to act at the time of transmission or reception.

[0008] In the cover 2B, the radio signal input from either the antenna 7 or 9A at the time of reception of the radio signal is amplified at the reception unit 11 through the circulator 10 and demodulated into digital signal at the modulation/demodulation unit 12B. This digital signal is output to the control unit 4B of the main body 1A. Moreover, the digital signal output from the control unit 4B of the main body 1A at the time of transmission of the radio signal is modulated at the modulation/demodulation unit 12B and then amplified at the transmission unit 13 so as to become transmission radio signal. This radio signal is radiated through the antenna 7 via the circulator 10.

[0009] The radio portable information terminal shown in FIG. 7 conducts antenna selecting diversity reception using the two antennas 7 and 9A. Such diversity reception is carried out by switching the antenna connected to the reception unit 11 at the time of starting the reception of signal to either the antenna 7 or 9A by the antenna switch 16 and comparing the level of the reception signal from the reception unit 11 at the modulation/demodulation unit 12B and connecting the antenna having a stronger reception signal level to the reception unit 11 in order to receive desired signal. Usually, since this reception is conducted at such a short cycle as mS unit, the antenna having a

larger reception signal level is selected every time the reception is switched to transmission.

[0010]

[Problem to be Solved by the Invention] The above-mentioned conventional portable radio information terminal having a housing consisting of a main body with an information processing unit received therein and a cover covering the main body and containing therein a radio unit is encountered with a problem to be described hereinafter even in the case where a rod-like whip antenna capable of obtaining a favorable gain comparatively easily is employed. When the cover is closed, the whip antenna is brought closer to a metal part had by the main body. As a result, the gain is lowered. Moreover, since the distance between the antenna attached to the cover and the information processing unit as a main noise source of the main body is reduced, the noises generated by the information processing unit enters the antenna, thus making it difficult to favorably receive the reception radio signal at the reception unit.

[0011] Moreover, in the case where antenna selecting diversity reception is conducted using a plurality of antennas, if an antenna is used having a high gain and comparatively intimately connected to the radio unit, the transmission radio signal enters the reception unit from the high gain transmission antenna and therefore, it sometimes occurs that only the low gain antenna must be used as the transmission antenna. Accordingly, even in the case where the high gain transmission antenna, when the cover is closed, is brought closer to the metal part of the main body and the gain is lowered, the low gain antenna must be used as a transmission antenna.

[0012] The above conventional portable radio information terminal has the following problem. Even in the case where the antenna selecting diversity reception system is employed in which the cover has an inverted-F antenna in addition to the whip antenna, when the cover is closed and noises (transmission radio signal) enter the reception unit from the whip antenna, the reception unit is caused to detect strong electric field strength by the noises. As a result, favorable diversity reception cannot be conducted. Although there can be contemplated that an error ratio of reception data is carried out in order to judge whether the cause for detecting a strong electric field strength is the noise or the desired signal, it has such shortcomings that much time is required for such judgment and the construction is complicated.

[0013]

[Means for Solving the Problem] A portable radio information terminal according to the present invention comprises a main body containing an information processing unit and a cover containing a radio unit and covering, when closed, a top surface of the main body, wherein a back side of the cover is brought closer to the top surface of the main body when the cover is closed and the back side of the cover is brought away from the top surface of the main body when the cover is open, the cover includes a first antenna disposed at an end part thereof and a second antenna including a conductor plane having an effect for shielding electric connection between the cover and the main body, and the cover further includes a reception unit for receiving a reception radio signal from the second antenna when the cover is closed and for conducting diversity reception of the reception radio signal through the first and second antennas when the cover is open.

[0014] The portable radio information terminal may be constructed such that when the cover is open, a transmission unit transmits a generated transmission radio signal through the first antenna, and when the cover is closed, the transmission unit transmits the transmission radio signal through the second antenna.

[0015] The portable radio information terminal may be constructed such that the cover further comprises a third antenna including a conductor plane having an effect for shielding an electromagnetic connection between the cover and the main body, the reception unit conducts diversity reception using the first and second antennas when the cover is open, and the reception unit conducts diversity reception using the second and third antennas when the cover is closed.

[0016] Since the portable radio information terminal according to the present invention is capable of conducting transmission of radio signal or antenna selecting diversity reception using the second antenna and/or the third antenna including a conductor plane having an effect for shielding electric connection between the cover and the main body and without using the first antenna such as a whip antenna having a strong electromagnetic connection with the main body even when the cover is closed, a favorable radio communication can be realized without being adversely affected by noises radiated from the main body.

[0017]

[Embodiment of the Invention] The present invention will now be described with reference to the drawings.

[0018] FIG. 1 is a block diagram showing one of the embodiments of a portable radio information terminal according to the present invention. FIG. 2 is a perspective view showing a state in which a cover 2 of the portable radio information terminal of FIG. 1 is open.

[0019] Referring first to FIG. 1, a basic construction of this portable radio information terminal is similar to that of a portable radio information terminal shown in FIG. 7. That is to say, this portable radio information terminal has such a construction that a shield plate 8 and a cover opening/closing detector 14 are attached to the portable radio information terminal of FIG. 7. In FIG. 1, those component elements indicated by reference numerals of FIG. 7 only eliminating the suffix therefrom, for example, the antenna 9 is basically the same in operation or construction as the component element indicated by the same reference numeral of FIG. 7 but they are slightly different. In the description of FIG. 1, only those elements and operation different from FIG. 7 will be described hereinafter in detail.

[0020] The cover 2 of the portable radio information terminal of FIG. 1 has two antennas, a whip antenna 7 projecting from the cover 2 and forming a rod-like configuration and an inverted-F antenna 9. The inverted-F antenna 9 has two conductor planes, a ground conductor having a GND potential and a radiating conductor disposed on the surface side of the cover 2 in such a manner as to be opposite to the ground conductor. A shield plate 8 having a GND potential and disposed at the bottom (back) on the main body side of the cover 2 corresponds to the ground conductor. A printed board with parts of the radio unit mounted thereon may be used as this shield plate 8. The

radiating conductor is provided with an inverted-F type electricity feed circuit.

[0021] The inverted-F antenna 9 exhibits favorable antenna characteristics irrespective of the opening/closing operation of the cover 2. The noises coming from the information processing unit of the main body 1 are shielded with the shield plate 8 and arrive at the radio unit in an extensively attenuated state. In this inverted-F antenna 9, since the surface of the shield plate 8 is brought closer to the surface of the main body 1 in a vertical direction as the cover 2 is opened, the shielding quantity of noises coming from the information processing unit to the radio unit is reduced. On the other hand, since the whip antenna 7 is separated from the top surface of the main body 1 when the cover 2 is open, it is hardly adversely affected by the noises coming from the information processing unit and the gain is high. Accordingly, it is effective for this portable radio information terminal to employ the antenna selecting diversity reception system in which when the cover 2 is open, both the whip antenna 7 and the inverted-F antenna 9 are used for receiving radio signal.

[0022] On the other hand, in the whip antenna 7 when the cover 2 is closed, the gain is lowered due to adverse effect of the conductive part and the metal part of the main body 1 and in addition, the whip antenna 7 is adversely affected by noises because the distance from the antenna 7 to the control unit 4 as a main source for generating noises is reduced. For this reason, when the cover 2 is closed, the radio signal is received only by the inverted-F antenna without using the whip antenna 7. That is to say, in the diversity reception system, since the antenna is selected by judging the level strength

of the reception signal, once the whip antenna 7 receives the noises, the whip antenna 7 is selected even in such a weak electric field as the noise level of the reception radio signal and the receiving sensibility is deteriorated. Therefore, when the cover 2 is closed, the whip antenna 7 is not used for receiving radio signal.

[0023] In view of the above, the main body 1 contains a cover opening/closing detector 14 for detecting the opening of the cover 2 when the characteristics of the inverted-F antenna 9 are lower than those of the whip antenna 7, for example, when the cover 2 is open a predetermined amount or more so that it can be judged by the S/N ratio. The cover opening/closing detector 14 may be a known micro-switch or the like capable of detecting the contact or approach between the upper surface of the main body 1 and the undersurface of the cover 2. The control unit 4 obtains the opening/closing information of the cover 2 from the cover opening/closing detector 14 and sending this cover opening/closing information to the modulation/demodulation unit 12 so as to use it for switch controlling, etc. of the transmission antenna.

[0024] Referring to FIG. 2, the portable radio information terminal has a display unit 5 arranged at the top surface of the main body 1 and a touch panel serving as an input unit 6 disposed under the display unit 5. By pressing a local area of the display unit 5 with a touch pen 15, the signal can be inputted into the input unit 6. The cover 2 has the shield plate 8 having the GND potential and arranged at the bottom side (back side) of the cover 2. This shield plate 8 is, as previously mentioned, a conductor plane forming a ground conductor of the inverted-F antenna 9. A radio unit 17 including a

transmission unit 13, a reception unit 11 and a modulation/demodulation unit 12, and the inverted-F antenna 9 are properly arranged from the shield plate 8 towards the top surface side of the cover 2. Since the radiating conductor of the inverted-F antenna 9 is shielded from the main body 1 side by the shield plate 8, it is hardly adversely affected by noises coming from the main body 1 side. The whip antenna 7 is disposed at the end part of the cover 2 such that the distal end part of the antenna 7 can project, and when the cover 2 is open serving the shaft 20 as a rotation shaft as shown, the whip antenna 7 is hardly adversely affected from the main body 1 side with a high gain. However, when the cover 2 is closed, the gain is readily deteriorated under the effect of the metal part and the conductive parts of the main body 1 and the whip antenna 7 is readily subjected to the effect of noises generated by the control unit 4. The shield plate 8 can be realized by making metal deposition on the interior of a housing of the cover 2 or on the surface of a plastic housing.

[0025] In the case where the inverted-F antenna 9 has a sufficient gain when the cover 2 is closed and the entry of noises is small owing to intimate connection with the radio unit 17 (reception unit 11) at the time of transmitting a transmission radio signal using this portable radio information terminal, it is preferred that the inverted-F antenna 9 is used rather than using the whip antenna 7 which is lowered in gain under the effect of the main body 1. That is to say, in this portable radio information terminal, although the cover 2 contains the radio unit 17 and the antennas 7, 9, the dimension is substantially established by the dimension of the display unit 5 of the main body 1. Accordingly, the internal mounting of the cover 2 can

easily offer an extra area and so the inverted-F antenna 9 can easily be arranged with a sufficient isolation from the radio unit 17.

[0026] FIG. 3 is a flowchart showing the operation of the portable radio information terminal according to the embodiment shown in FIG. 1.

[0027] In the case where the portable radio information terminal of FIG. 1 conducts the transmission/reception of data with a radio signal, the reception and transmission are repeated with such a short time interval as an mS unit. Accordingly, in the case where a plurality of antennas are diversity operated, it is necessary to receive the reception signal for detecting the receiving level, separately from the reception radio signal which is necessary as the intended information at the time of start of reception of signal by properly switching the antennas 7 and 9. So, the radio control unit (modulation/demodulation unit 12) prepares to receive the receiving level of radio signal which is inputted into the reception unit 11 (Step 101). At that time, the control unit 4 receives opening/closing information of the cover 2 from the cover opening/closing detector 14 and informs the radio control unit of it (Step 102). When the cover 2 is open (open in Step 102), the distance is large between the whip antenna 7 and the control unit 4 and the top surface of the main body 1 and therefore, the whip antenna 7 is hardly adversely affected by noises and the gain is large. Accordingly, the radio control unit controls such that the radio signal is received by means of diversity reception through the whip antenna 7 and the inverted-F antenna 9.

[0028] So, the radio control unit switches the antenna first to the inverted-F antenna 9 with the antenna switch 16 and detects the receiving level of the radio signal from the reception unit 11 which is connected to the inverted-F

antenna 9 (Step 103). Subsequently, the radio control unit switches the antenna switch 16 and detects the receiving level of the signal coming from the whip antenna 7 (Step 104). If the receiving level from the inverted-F antenna 9 is larger (larger in Step 105), the radio control unit selects the signal coming from the inverted-F antenna 9 as a reception radio signal (Step 107), and the reception unit 11 receives the radio signal coming from the inverted-F antenna 9 (Step 108). In Step 105, if the receiving level of the signal coming from the whip antenna 7 is larger (smaller in Step 105), the radio control unit selects the signal coming from the whip antenna 7 as a reception radio signal (Step 109), and the reception unit 11 receives the radio signal coming from the whip antenna 7 (Step 108).

[0029] On the other hand, when the cover 2 is closed (closed in Step 102), the whip antenna 7 is not only lowered in gain due to adverse effect from the conductive part and the metal part of the main body 1 but also reduced in distance between the whip antenna 7 and the control unit 4. Therefore, the whip antenna 7 is subjected to adverse effect from noises. For this reason, at the time of receiving the reception radio signal, the reception unit 11 does not use the whip antenna 7 and receives only the radio signal coming from the inverted-F antenna 9 (Steps 107 and 108). In the antenna selecting diversity reception system, the antenna is selected by determining the strength of the reception signal level. Therefore, when the reception unit 11 receives the noises coming from the whip antenna 7, it selects the whip antenna 7 with the radio signal having a weak electric field of a low noise level and the receiving sensitivity is deteriorated. Therefore, the whip antenna 7 is not used in the antenna selecting diversity reception system.

[0030] In this portable radio information terminal, signal transmission is carried out after the reception time. Since the level of the transmission radio signal is high at the time of transmission, adverse effect attributable to noises coming from the information processing unit becomes relatively small and the whip antenna 7 is used for transmitting the transmission radio signal (Step 110). Since the whip antenna 7 can easily realize a high gain than the inverted-F antenna 9, the whip antenna 7 is used in this example. However, it is possible that the inverted-F antenna 9 is used as a transmission antenna by obtaining a sufficient size and isolation from the radio unit 17 by effectively utilizing the construction of the cover 2.

[0031] When transmission of the radio signal is completed in unit time, reception of the radio signal is started again (Step 101). Actually, the time interval between the reception and the transmission and between the transmission and the next reception is equal to the length of that portion which is obtained by means of time division with other terminal.

[0032] FIG. 4 is a block diagram showing another embodiment of a portable radio information terminal according to the present invention. FIG. 5 is a perspective view showing a state in which the cover 2A of the portable radio information terminal of FIG. 4 is open.

[0033] Referring both FIGS. 4 and 5, this portable radio information terminal has a construction in which an antenna switch 21 and an inverted-F antenna 22 are added to the cover 2 of the portable radio information terminal of FIG. 1. As a result of addition of the antenna switch 21 and the inverted-F antenna 22, the cover 2, the shield plate 8, the control unit 4 and the modulation/demodulation unit (radio control unit) 12 of FIG. 1 are

slightly changed in function. Reference numerals representing those component elements are allotted with a suffix A so as to indicate some differences from those of FIG. 1. In the following description of FIGS. 4 and 5, different parts from FIGS. 1 and 2 will be described in detail.

[0034] In this portable radio information terminal, the inverted-F antenna 9 is remote from the radio unit 17 and a high gain is obtained when the cover 2A is closed. In contrast, the inverted-F antenna 22 is located near the radio unit 17 and a lower gain is obtained than in the case with the inverted-F antenna 9. For this reason, the inverted-F antenna 22 becomes stronger in signal connection with the radio unit 17 than the inverted-F antenna 9. Both the inverted-F antennas 9 and 22 use the shield plate 8A as a ground conductor (conductor plane) and therefore, they have, of course, the shielding effect of noises to the radio unit 17 with respect to the control unit 6A of the main body 1.

[0035] The inverted-F antenna 22 is used only at the time of diversity reception when the cover 2A is closed. The inverted-F antenna 9 is used for diversity reception and transmission irrespective of opening/closing of the cover 2A. On the other hand, when the cover 2A is open, the whip antenna 7 conducts diversity reception together with the inverted-F antenna 9 separated away from the radio unit 17. At the time of transmission, the antenna 7 or 9, which is selected at the time of reception is used.

[0036] The whip antenna 7 and the inverted-F antenna 22 are switched to each other by the antenna switch 21. The common terminal of the antenna switch 22 and the inverted-F antenna 9 are switched to each other by the antenna switch 16. Those switching operations are conducted by the radio

control unit which properly controls taking into consideration the opening/closing of the cover 2.

[0037] Referring to FIG. 5, the shield plate 8A having the GND potential is disposed at the bottom side (back side) of the cover 2A, and the radio unit 17 and the inverted-F antennas 9 and 22 are arranged in its outside (outer surface) direction. The inverted-F antenna 22 is disposed at an area near the radio unit 17 and more tightly connected to the radio unit 17. Therefore, the antenna 22 is used only for the purpose of reception. On the other hand, the inverted-F antenna 9 is far away and isolated from the radio unit 17 and a high gain can be obtained. Accordingly, the inverted-F antenna 9 is used both for transmission and reception. The inverted-F antennas 9 and 22 are shielded from the main body 1 side by the shield plate 8A and hardly adversely affected by noises. The whip antenna 7 is disposed at the end part of the cover 2A as in FIG. 2. As shown, when the cover 2A is open, the whip antenna 7 has a high gain and is hardly adversely affected by the main body side. However, when the cover 2A is closed, the gain is deteriorated under the effect of the metal part and the conductive parts of the main body 1 and the whip antenna 7 is readily subjected to adverse effect of noises coming from the control unit 4A. A printed board for mounting thereon the parts of the radio unit 17 can be used as the shield plate 8A. The shield plate 8A can also be realized by making metal deposition on the interior or on the outer surface of the housing of the cover 2A.

[0038] FIG. 6 is a flowchart showing the operation of the portable radio information terminal according to the embodiment shown in FIG. 4.

[0039] In the embodiment of FIG. 4, the transmission and reception are also repeated at such a short time interval as mS unit in the case where the portable radio information terminal transmits and receives data with radio signal. Accordingly, in the case where a plurality of antennas are diversity operated, it is necessary to receive the reception signal for detecting the receiving level, separately from the reception radio signal which is necessary as the intended information at the time of start of reception of signal by properly switching the antennas. So, the radio control unit (modulation/demodulation unit 12A) prepares to receive the receiving level of radio signal which is inputted into the reception unit 11 (Step 201).

[0040] When the cover 2A is open (open in Step 202), the radio control unit connects the antenna switches 16 and 21 together so that the whip antenna 7 is selected as another antenna together with the inverted-F antenna 9, as antennas at the time of antenna selecting diversity reception (Step 203). The radio control unit makes the inverted-F antenna 9 to detect the receiving level of the receiving level detecting radio signal (Step 204). Subsequently, the radio control unit switches the inverted-F antenna 9 to the whip antenna 7 to detect the receiving level of the radio signal (Step 205). If the receiving level of the inverted-F antenna 9 is larger (larger in Step 206), the radio control unit selects the radio signal coming from the inverted-F antenna 9 as input radio signal (Step 207) and the reception unit 11 serves this radio signal as reception signal (Step 208). In Step 206, if the receiving level from the whip antenna 7 is larger (smaller in Step 206), the radio control unit selects the signal coming from the whip antenna 7 as reception radio signal

(Step 210), and the reception unit 11 receives the radio signal coming from the whip antenna 7 (Step 208).

[0041] After receipt of the reception radio signal, if the diversity selected antenna is the inverted-F antenna 9 (Yes in Step 211), the radio control unit makes the transmission radio signal through the diversity selected inverted-F antenna 9 (Step 209). In case of this portable radio information terminal, the inverted-F antenna 9 can be made high gain in terms of layout and it can also be isolated from a radio unit 17A. Therefore, the inverted-F antenna 9 is used as a transmission antenna.

[0042] In Step 206 following the open in Step 202, if the whip antenna 7 is larger in receiving level than the inverted-F antenna 9 (smaller in Step 206), the radio control unit selects the radio signal coming from the whip antenna 7 as input signal to the reception unit 11 (Step 210), and the reception unit 11 serves this radio signal as reception signal (Step 208).

[0043] After receipt of the reception radio signal, if the diversity selected antenna is the inverted-F antenna 9 (Yes in Step 211), the transmission radio signal is also transmitted through the inverted-F antenna 9 (Step 212). If the diversity selected antenna is the whip antenna 7 (No in Step 211), the transmission radio signal is also transmitted through the whip antenna 7 (Step 212). After transmission, next reception is started (Step 201).

[0044] When the cover 2A is closed in Step 202 (closed in Step 202), the radio control unit connects the antenna switches 16 and 21 together so that the inverted-F antenna 22 is selected as another antenna together with the inverted-F antenna 9, as antennas at the time of antenna selecting diversity reception (Step 213). The radio control unit makes the inverted-F antenna 9

to detect the receiving level of the receiving level detecting radio signal (Step 214). Subsequently, the radio control unit switches the inverted-F antenna 9 to the inverted-F antenna 22 to detect the receiving level of the radio signal (Step 215). If the receiving level of the inverted-F antenna 9 is larger (larger in Step 206), the radio control unit selects the radio signal coming from the inverted-F antenna 9 as input radio signal (Step 207) and the reception unit 11 serves this radio signal as reception signal (Step 208).

[0045] After receipt of the reception radio signal, if the diversity selected antenna is the inverted-F antenna 9 (Yes in Step 211), the radio control unit makes the transmission radio signal through the diversity selected inverted-F antenna 9 (Step 209). If the receiving level from the inverted-F antenna 22 is larger than that through the inverted-F antenna 9 (smaller in Step 206), the radio control unit selects the signal coming from the inverted-F antenna 22 as input signal to the reception unit 11 (Step 210), and the reception unit 11 serves this radio signal as reception signal (Step 208). After receipt of the reception radio signal through the inverted-F antenna 22, the transmission radio signal is transmitted. This transmission of the transmission radio signal is made through the whip antenna 7 (No in Step 211 and Step 212). The reason is as follows. Since the diversity selected inverted-F antenna 22 is not isolated from the radio unit 17, it cannot be used for the purpose of transmission. After transmission of the transmission radio signal, the next reception is started (Step 201).

[0046]

[Effect of the Invention] As described hereinbefore, according to the present invention, there is provided a portable radio information terminal comprising

a main body containing an information processing unit and a cover containing a radio unit and covering, when closed, a top surface of the main body, wherein a back side of the cover is brought closer to the top surface of the main body when the cover is closed and the back side of the cover is brought away from the top surface of the main body when the cover is open, the cover includes a first antenna disposed at an end part thereof and a second antenna including a conductor plane having an effect for shielding electric connection between the cover and the main body, and the cover further includes a reception unit for receiving a reception radio signal from the second antenna when the cover is closed and for conducting diversity reception of the reception radio signal through the first and second antennas when the cover is open. Accordingly, it is not necessary to use only the whip antenna in which gain is lowered when the cover is closed. Since diversity reception and transmission of radio signal can be made by properly selecting a plurality of antennas, even in the portable radio information terminal in which the control unit is contained in the main body, a favorable radio communication can be realized without being adversely affected by noises radiated from the main body and while maintaining a high gain.

[0047] If the portable radio information terminal is constructed such that when the cover is open, radio signal is transmitted through the first antenna, and when the cover is closed, radio signal is transmitted through the second antenna, and if the portable radio information terminal is constructed such that the cover further comprises a third antenna including a conductor plane having an effect for shielding an electromagnetic connection between the cover and the main body as in the second antenna, radio signal is received by

diversity controlling of the first and second antennas when the cover is closed, and diversity reception is conducted through the second and third antennas when the cover is open, adverse effect of noises generated from the main body to the radio unit contained in the cover can be further reduced.

[Brief Description of the Drawings]

[FIG. 1] A block diagram showing one embodiment of a portable radio information terminal according to the present invention.

[FIG. 2] A perspective view showing a state in which a cover 2 of the portable radio information terminal of FIG. 1 is open.

[FIG. 3] A flowchart showing operation of the portable radio information terminal according to the embodiment of FIG. 1.

[FIG. 4] A block diagram showing another embodiment of a portable radio information terminal according to the present invention.

[FIG. 5] A perspective view showing a state in which a cover 2A of the portable radio information terminal of FIG. 4 is open.

[FIG. 6] A flowchart showing operation of the portable radio information terminal of FIG. 4.

[FIG. 7] A block diagram showing one embodiment of a radio portable information terminal according to the prior art.